

WHAT IS CLAIMED IS:

1. Foamed cellular particles for use in
5 forming foam articles and said foamed cellular
particles formed from expandable polymer
particles, said foamed cellular particles
having a bulk density ranging between about
10 34.3 pounds per cubic foot (550 kilograms per
cubic meter) and 12.5 pounds per cubic foot
(200 kilograms per cubic meter) and a blowing
agent in an amount less than 6.0 wt % based on
the polymer, and for a predetermined time at
room temperature having a blowing agent weight
15 loss at least 15% to 50% lower compared to said
expandable particles in the same predetermined
time at room temperature.

2. Foamed cellular particles of claim 1
wherein said blowing agent is selected from the
20 group consisting of acetone, methyl acetate,
butane, hexane, n-pentane, cyclopentane,
cyclohexane, isopentane, isobutane, neopentane,
HFC's, CFC's, HCFC's, water, and mixtures
thereof in combination with carbon dioxide,
25 nitrogen, and air in an amount ranging between
2.0 wt% and 5.0 wt %.

3. Foamed cellular particles of claim 2
wherein said blowing agent is selected from the
group consisting of acetone, methyl acetate,
30 butane, hexane, n-pentane, cyclopentane,
cyclohexane, isopentane, isobutane, neopentane,
and mixtures thereof in an amount ranging
between 2.5 wt % and 3.5 wt %.

4. Foamed cellular particles of claim 3 wherein said blowing agent is n-pentane and mixtures thereof in an amount ranging between 2.5 wt % and 3.5 wt %.

5 5. Foamed cellular particles of claim 1 wherein said particles contain an established cell structure comprising an average cell size ranging between 5 and 100 microns and a fixed number of cells.

10 6. Foamed cellular particles of claim 1 wherein said foamed cellular particles are comprised of a polymer composition comprised of: i) at least one C₈-C₁₂ vinyl aromatic monomer which is unsubstituted or substituted
15 by one or more substituents selected from the group consisting of C₁₋₆ alkyl radicals and halogen atoms in an amount ranging from about 70 to about 100 weight %, ii) at least one monomer selected from the group consisting of
20 C₃₋₆ ethylenically unsaturated carboxylic acids, anhydrides, imides and C₁₋₁₂ alkyl and alkoxyalkyl esters thereof, and C₃₋₆ ethylenically unsaturated nitriles in an amount ranging from about 30 to 0 weight % based on
25 the weight of the polymer composition, and iii) a blowing agent.

7. Foamed cellular particles of claim 6 wherein i) is selected from the group consisting of styrene, alpha methyl styrene,
30 para methyl styrene, chlorostyrene and bromo-styrene, ii) is selected from the group consisting of methyl acrylate, ethyl acrylate, butyl acrylate, methyl methacrylate, ethyl

methacrylate, acrylonitrile, methacrylonitrile, maleic anhydride, acrylic acid, methacrylic acid, itaconic acid, and maimide, and iii) is selected from the group consisting of acetone, methyl acetate, butane, hexane, n-pentane, cyclopentane, isopentane, isobutane, neopentane, HFC's, CFC's, HCFC's, water and mixtures thereof.

8. Foamed cellular particles of claim 7 wherein i) is styrene, ii) is butyl acrylate, and iii) is n-pentane and mixtures thereof.

9. Foamed cellular particles of claim 1 wherein said foamed cellular particles are comprised of a polymer composition comprised of: i) at least one C₈-C₁₂ vinyl aromatic monomer which is unsubstituted or substituted by one or more substituents selected from the group consisting of C₁₋₆ alkyl radicals and halogen atoms in an amount ranging from about 70 to about 100 weight %, ii) at least one polymer selected from the group consisting of polyphenylene oxide, butadiene rubber, and high impact polystyrene in an amount ranging between about 30 and 0 weight and iii) a blowing agent.

10. Foamed cellular particles of claim 9 wherein i) is selected from the group consisting of styrene, alpha methyl styrene, para methyl styrene, chlorostyrene and bromostyrene and iii) is selected from the group consisting of acetone, methyl acetate, butane, hexane, n-pentane, cyclopentane, isopentane, isobutane, neopentane, HFC's, CFC's, HCFC's, water, and mixtures thereof.

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11. Foamed cellular particles of claim 1
wherein said expandable polymer particles are
formed in a polymerization process selected
from the group consisting of suspension, bulk,
5 and solution.
12. Foamed cellular particles of claim 11
wherein said polymerization process is a
suspension process.
13. Foamed cellular particles of claim 12
10 wherein said suspension process is selected
from the group consisting of one-step and two-
step processes.
14. Foamed cellular particles of claim 1
wherein said expandable polymer particles are
15 formed in an extrusion process.
15. Foamed cellular particles of claim 1
wherein said foamed cellular particles are
formed in a heating process selected from the
group consisting of contact heating, non-
20 contact heating, infrared heating, microwave
heating, dielectric heating, and radio
frequency heating.
16. Foamed cellular particles of claim 1
wherein said foamed cellular particles are
25 formed in a heating process including a fluid
bed dryer.
17. Foamed cellular particles of claim 1
wherein said foamed cellular particles are
formed in a heating process including a pre-
30 expander.
18. Foamed cellular particles of claim 1
wherein said expandable particles are produced

from a polymer composition in a suspension polymerization process, the steps comprising:

admixing at least one styrenic monomer in an amount ranging from about 70 to about 100 weight % based on the amount of polymer composition with at least one vinyl group monomer in an amount ranging from about 30 to 0 weight % based on the polymer composition to form expandable particles, and

prior to, during, or after said suspension polymerization process mixing in said blowing agent selected from the group consisting of acetone, methyl acetate, butane, n-pentane, cyclopentane, cyclohexane, isopentane, neopentane, isobutane, hexane, HFC's, CFC's, HCFC's, water, and mixtures thereof with said styrenic monomer and vinyl group monomer.

19. Foamed cellular particles of claim 1 wherein said expandable particles are produced from a polymer composition in a suspension polymerization process, the steps comprising:

admixing at least one styrenic monomer in an amount ranging from about 70 to about 100 weight % based on the amount of polymer composition with at least one polymer selected from the group consisting of polyphenylene oxide, butadiene rubber, and high impact polystyrene in an amount ranging between about 30 and 0 weight % based on the polymer composition to form expandable particles, and

prior to, during, or after said suspension polymerization process, mixing in said blowing agent selected from the group consisting of

acetone, methyl acetate, butane, n-pentane,
cyclopentane, cyclohexane, isopentane,
neopentane, isobutane, hexane, HFC's, CFC's,
HCFC's, water, and mixtures thereof with said
styrenic monomer and said polymer.

20. Foamed cellular particles of claim 1
wherein said expandable particles are produced
from a polymer composition in an extrusion
process, the steps comprising:

admixing a styrenic polymer in an amount
ranging between about 70 and about 100 weight %
based on the amount of polymer composition with
at least one vinyl group polymer in an amount
ranging between about 30 and 0 weight % based
on the polymer composition,

heating and admixing said polymer
composition to obtain a polymer melt and
injecting said blowing agent selected from the
group consisting of acetone, methyl acetate,
butane, n-pentane, isobutane, cyclopentane,
cyclohexane, isopentane, neopentane, hexane,
HFC's, CFC's, HCFC's, water, and mixtures
thereof,

extruding the polymer melt as a strand and
chopping it into pellets, and

heating the pellets to a temperature range
of about 70 and 110 °C at a pressure range of
about 10.1 psi absolute (70 kPa) to about 24.7
psi absolute (170 kPa) thereby forming said
foamed cellular particles.

21. Foamed cellular particles of claim 1
wherein said expandable particles are produced

from a polymer composition in an extrusion process, the steps comprising:

5 admixing a styrenic polymer in an amount ranging between about 70 and about 100 weight % based on the amount of polymer composition with at least one polymer selected from the group consisting of polyphenylene oxide, butadiene rubber, and high impact polystyrene in an amount ranging between about 30 and 0 weight %
10 based on the polymer composition,

 heating and admixing said polymer composition to obtain a polymer melt,

 extruding the polymer melt as a strand and chopping said strand into pellets,

15 impregnating the pellets with said blowing agent selected from the group consisting of acetone, methyl acetate, butane, n-pentane, isobutane, cyclopentane, cyclohexane, isopentane, neopentane, hexane, HFC's, CFC's, HCFC's, water, and mixtures thereof, and
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 heating the pellets to a temperature range of about 70 and 110 °C at a pressure range of about 10.1 psi absolute (70 kPa) to about 24.7 psi absolute (170 kPa) thereby forming said
25 foamed cellular particles.

22. Foamed cellular particles of claim 1 wherein at least said foamed particles contain a coating composition.

23. Foam particles of claim 22 wherein said
30 coating composition is selected from the group consisting of silicones, metals, and glycerol carboxylates, and mixtures thereof.

24. Foam particles of claim 23 wherein said glycerol carboxylates are selected from the group consisting of glycerol mono-stearate, glycerol di-stearate, glycerol tri-stearate, zinc stearate, calcium stearate, and magnesium stearate, and mixtures thereof.

25. A system for extending the shelf life of expandable polymer particles by making said foamed cellular particles of claim 1.

26. A foam article formed from the foamed cellular particles of claim 1 and having a bulk density ranging between about 0.50 pounds per cubic foot (8.0 kilograms per cubic meter) and 6.0 pounds per cubic foot (96.1 kilograms per cubic meter).

27. A process for preparing foamed cellular particles comprised of a polymer composition for use in making foam articles, the steps comprising:

a) heating expandable polymer particles with a bulk density ranging between about 40 pounds per cubic foot (641 kilograms per cubic meter) and about 32.0 pounds per cubic foot (513 kilograms per cubic meter) and a blowing agent in an amount less than about 10.0 weight % based on the weight of the polymer composition at a temperature ranging between about 70 and 110°C and at a pressure ranging between about 10.1 psi absolute (70 kPa) and about 24.7 psi absolute (170 kPa) to form said foamed cellular particles with a bulk density ranging from between 34.3 pounds per cubic foot (550 kilograms per cubic meter) and about 12.5

pounds per cubic foot (200 kilograms per cubic meter) and a blowing agent in an amount less than about 6.0 weight % based on the weight of the polymer composition.

5 28. A process of claim 27 wherein step a) is performed at a polymer producer's plant, and the steps further comprising:

10 b) at a foam molder's plant, subjecting said foamed cellular particles to conventional equipment to form foam articles with a bulk density ranging between about 0.80 pounds per cubic foot (12.8)kilograms per cubic meter) and 6.0 pounds per cubic foot (96.1 kilograms per cubic meter) without the need to impregnate
15 said foamed cellular particles with an additional amount of blowing agent prior to expanding and molding.

20 29. A system for optimizing the shipping and packaging of polymer particles for use in making foam articles, the steps comprising:

at the polymer producer's plant,.

25 a) using expandable polymer particles with a bulk density ranging between about 40 pounds per cubic foot (641 kilograms per cubic meter) and about 32.0 pounds per cubic foot (513 kilograms per cubic meter) and a blowing agent in an amount less than about 10.0 weight % based on the weight of the polymer composition and heating said expandable
30 particles at a temperature ranging between about 70°C and about 110° C and at a pressure ranging between about 10.1 psi absolute (70 kPa absolute)and about 24.7 psi absolute (170 kPa

absolute) to form foamed cellular particles
with a bulk density ranging from between about
34.3 pounds per cubic foot (550 kilograms per
cubic meter) and about 12.5 pounds per cubic
foot (200 kilograms per cubic meter) and with a
blowing agent in an amount less than 6.0 weight
% based on the weight of the polymer
composition;

b) packaging said foamed cellular
particles of step a) whereby the required
strength of the packages used in transporting
the foamed cellular particles of step a) is
lower than the required strength of packages
used when transporting the expandable particles
with a higher bulk density and higher blowing
agent level of step a); and

c) transporting said foamed cellular
particles at a total shipment weight
substantially equal to the total shipment
weight of the expandable particles of step a)
when transporting said expandable particles.
30. A system of claim 29 wherein in step a)
said expandable particles are heated at a
temperature ranging between 80°C and 110°C and
at a pressure of about 13.8 psi absolute (95
kPa absolute) and about 16 psi absolute (110
kPa absolute) for about .05 to 60 minutes;
wherein the bulk density of said foamed
cellular particles ranges between about 28.1
pounds per cubic foot (450 kilograms per cubic
meter) and about 21.9 pounds per cubic foot
(350 kilograms per cubic meter); and wherein
said blowing agent in the foamed cellular

particles is in an amount ranging between about 2.0 wt % and 5.0 wt %.

31. A system of claim 29 wherein said blowing agent is selected from the group consisting of acetone, methyl acetate, butane, hexane, n-pentane, cyclopentane, cyclohexane, isobutane, isopentane, neopentane, HFC's, CFC's, HCFC's, water, and mixtures thereof in combination with carbon dioxide, nitrogen, and air.

32. A system of claim 31 wherein said blowing agent is selected from the group consisting of acetone, methyl acetate, butane, hexane, n-pentane, cyclopentane, cyclohexane, isopentane, isobutane, neopentane, and mixtures thereof in an amount ranging between 2.5 and 3.5 weight % based on the weight of the polymer composition.

33. A system of claim 32 wherein said blowing agent is selected from the group consisting of pentane and mixtures thereof in an amount ranging between 2.5 and 3.5 weight % based on the weight of the polymer composition.

34. A system of claim 29 wherein the packages used in transporting the cellular particles are selected from the group consisting of paper bags, plastic film bags, fiber cartons, metal drums, fiber drums, bulk bags, and returnable packaging.

35. A system of claim 29 wherein the total weight of the foamed cellular particles of step c) transported by said transportation means is about 30,000 to about 50,000 pounds.

36. A system of claim 29 wherein said expandable polymer particles are formed in a

polymerization process selected from the group consisting of suspension, bulk, and solution.

37. A system of claim 36 wherein said polymerization process is a suspension process.

38. A system of claim 37 wherein said suspension polymerization process is selected from the group consisting of one-step and two-step processes.

39. A system of claim 29 wherein said expandable polymer particles are formed in an extrusion process.

40. A system of claim 29 wherein said foamed cellular particles are transported to a foam molder's plant and the steps further comprising:

d) in said foam molder's plant, subjecting said foamed cellular particles to conventional equipment to form a foam article with a bulk density ranging between about 0.80 pounds per cubic foot (12.8 kilograms per cubic meter) and 6.0 pounds per cubic foot (96.1 kilograms per cubic meter) without the need to impregnate said foamed cellular particles with an additional amount of blowing agent prior to expanding and molding.

41. A system of claim 29 wherein said foamed cellular particles are formed in a heating process selected from the group consisting of contact heating, non-contact heating, infrared heating, microwave heating, dielectric heating, and radio frequency heating in said plant of said polymer producer.

42. A system of claim 31 wherein said foamed

cellular particles are formed in a heating process including a fluid bed dryer.

43. A system of claim 29 wherein each said foamed cellular particle has an established cell structure comprising an average cell size ranging between 5 and 100 microns and a fixed number of cells.

44. A system of claim 29 wherein said expandable particles are produced from a polymer composition in a suspension polymerization process, the steps comprising:

admixing at least one styrenic monomer in an amount ranging from about 70 to about 100 weight % based on the amount of polymer composition with at least one vinyl group monomer in an amount ranging from about 30 to 0 weight % based on the polymer composition to form expandable particles, and

prior to, during, or after said suspension polymerization process mixing in said blowing agent selected from the group consisting of acetone, methyl acetate, butane, n-pentane, cyclopentane, cyclohexane, isopentane, neopentane, isobutane, hexane, HFC's, CFC's, HCFC's, water, and mixtures thereof with said styrenic monomer and vinyl group monomer.

45. A system of claim 29 wherein said expandable particles are produced from a polymer composition in a suspension polymerization process, the steps comprising:

admixing at least one styrenic monomer in an amount ranging from about 70 to about 100 weight % based on the amount of polymer

composition with at least one polymer selected from the group consisting of polyphenylene oxide, butadiene rubber, and high polystyrene in an amount ranging between about 30 and 0 weight % based on the polymer composition to form expandable particles, and

prior to, during, or after said suspension polymerization process, mixing in said blowing agent selected from the group consisting of acetone, methyl acetate, butane, n-pentane, cyclopentane, cyclohexane, isopentane, neopentane, isobutane, hexane, HFC's, CFC's, HCFC's, water, and mixtures thereof with said styrenic monomer and said polymer.

46. A system of claim 29 wherein said expandable particles are produced from a polymer composition in an extrusion process, the steps comprising:

admixing a styrenic polymer in an amount ranging between about 70 and about 100 weight % based on the amount of polymer composition with at least one vinyl group polymer in an amount ranging between about 30 and 0 weight % based on the polymer composition,

heating and admixing said polymer composition to obtain a polymer melt and injecting said blowing agent selected from the group consisting of acetone, methyl acetate, butane, n-pentane, isobutane, cyclopentane, cyclohexane, isopentane, neopentane, hexane, HFC's, CFC's, HCFC's, water, and mixtures thereof,

extruding the polymer melt as a strand and chopping it into pellets, and

heating the pellets to said temperature range of about 70 and 110 °C at said pressure range of about 10.1 psi absolute to about 24.7
5 psi absolute thereby forming said foamed cellular particles.

47. A system of claim 29 wherein said expandable particles are produced from a
10 polymer composition in an extrusion process, the steps comprising:

admixing a styrenic polymer in an amount ranging between about 70 and about 100 weight % based on the amount of polymer composition with
15 at least one polymer selected from the group consisting of polyphenylene oxide, butadiene rubber, and high impact polystyrene in an amount ranging between about 30 and 0 weight % based on the polymer composition,

20 heating and admixing said polymer composition to obtain a polymer melt,

extruding the polymer melt as a strand and chopping said strand into pellets,

impregnating the pellets with said blowing
25 agent selected from the group consisting of acetone, methyl acetate, butane, n-pentane, isobutane, cyclopentane, cyclohexane, isopentane, neopentane, hexane, HFC's, CFC's, HCFC's, water, and mixtures thereof, and

30 heating the pellets to said temperature range of about 70 and 110 °C at said pressure range of about 10.1 psi absolute to about 24.7

psi absolute thereby forming said foamed cellular particles.

48. A system of claim 29 the steps further comprising:

5 prior to, during, or after step a) applying a coating composition to said expandable polymer particles or to said foamed cellular particles.

10 49. Foamed cellular particles of claim 1 wherein said expandable particles are produced from a polymer composition formed in a polymerization process in an extruder, the steps comprising:

15 admixing a styrenic monomer in an amount ranging between about 70 and 100 weight % based on the amount of monomer composition with at least one vinyl group monomer in an amount ranging between about 30 and 0 weight % based on the monomer composition to form said polymer composition,

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 heating said polymer composition to obtain a polymer melt and injecting said blowing agent selected from the group consisting of acetone, methyl acetate, butane, n-pentane, isobutane, cyclopentane, cyclohexane, isopentane, neopentane, hexane, HFC's, CFC's, HCFC's, water, and mixtures thereof,

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 extruding the polymer melt as a strand and chopping it into pellets, and

30 heating the pellets to a temperature range of about 70 and 110 °C at a pressure range of about 10.1 psi absolute (70kPA) to about 24.7

psi absolute (170 kPA) thereby forming said foamed cellular particles.

50. A system of claim 29 wherein said expandable particles are produced from a polymer composition formed in a polymerization process in an extruder, the steps comprising:

admixing a styrenic monomer in an amount ranging between about 70 and 100 weight % based on the amount of monomer composition with at least one vinyl group monomer in an amount ranging between about 30 and 0 weight % based on the monomer composition to form said polymer composition,

heating said polymer composition to obtain a polymer melt and injecting said blowing agent selected from the group consisting of acetone, methyl acetate, butane, n-pentane, isobutane, cyclopentane, cyclohexane, isopentane, neopentane, hexane, HFC's, CFC's, HCFC's, water, and mixtures thereof,

extruding the polymer melt as a strand and chopping it into pellets, and

heating the pellets to a temperature range of about 70 and 110 °C at a pressure range of about 10.1 psi absolute (70kPA) to about 24.7 psi absolute (170 kPA) thereby forming said foamed cellular particles.